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December 1976

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Ontario

Ministry of the Environment

P. G. Cockburn
Director
Central Region

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Report Prepared By:
Technical Support Section

TABLE OF CONTENTS

INTRODUCTION 1

DESCRIPTION OF STUDY AREAS 5
Mimico Creek-Humber Bay Waterfront Areas. 5
Bluffer's Park Waterfront Area. 6

METHODS 7

SEDIMENT DESCRIPTION 8
Mimico-Humber Site 8
Bluffer's Site 9

BENTHIC INVERTEBRATE COMMUNITY STRUCTURE 10
Mimico-Humber Site 10
Bluffer's Site 13

WATER QUALITY STATUS 15

LANDFILL EFFECTS 16

IMPACT OF HUMBER SEWAGE TREATMENT PLANT. 17

GENERAL DISCUSSION 18

RECOMMENDATION 18

REFERENCES 19

INTRODUCTION

The Ministry of the Environment has been actively involved in assessing the impact of marine construction projects on water resources since 1970. In 1972 an extensive landfilling program on the Toronto waterfront was started by the Metro Toronto and Region Conservation Authority (MTRCA).

Studies to assess the impact of the landfill sites on water and sediment quality have been undertaken recently (eg: Wilkins, 1974; MTRCA's Waterfront Environmental Monitoring Program, 1975, 1976). When the present survey was initiated very little information on the effect of landfill on benthic macroinvertebrate organisms was available. As biological information provides a powerful tool in assessing the environmental impact of marine construction activities, the need for a benthic fauna study in the vicinity of Toronto waterfront landfill sites was expressed.

A survey in the vicinity of selected landfill sites was undertaken to:

a. outline the benthic fauna in the vicinity of the sites.

b. assess the effects of the landfills on the water quality of the area as indicated by the benthic organisms.

Three waterfront landfill areas were chosen for study: Mimico Creek Phase I, Humber Bay and Bluffer's Park Waterfront Area (see Figures 1 & 2). The Mimico and Humber sites, for study purposes, were considered as a single unit.

FIG. I - SAMPLING STATION LOCATIONS, MIMICO CR. - HUMBER BAY LANDFILL SITE

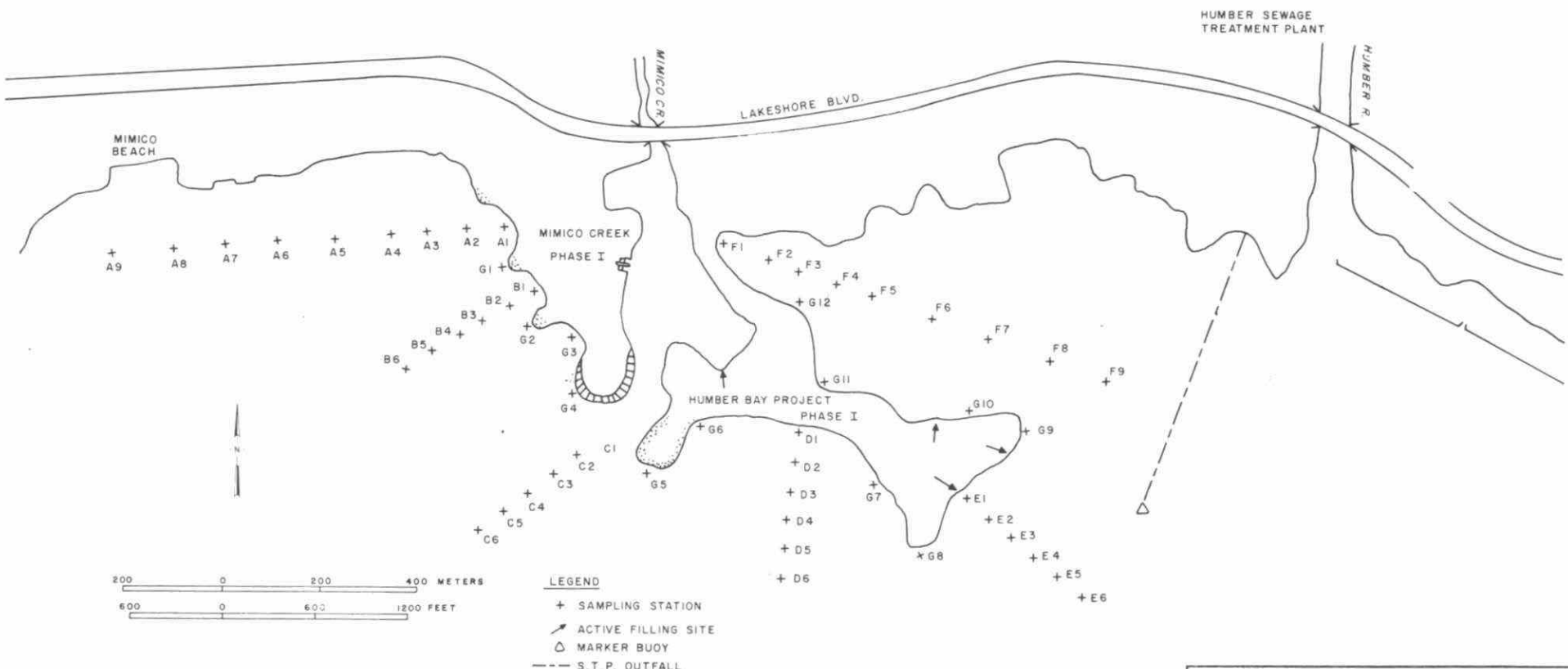

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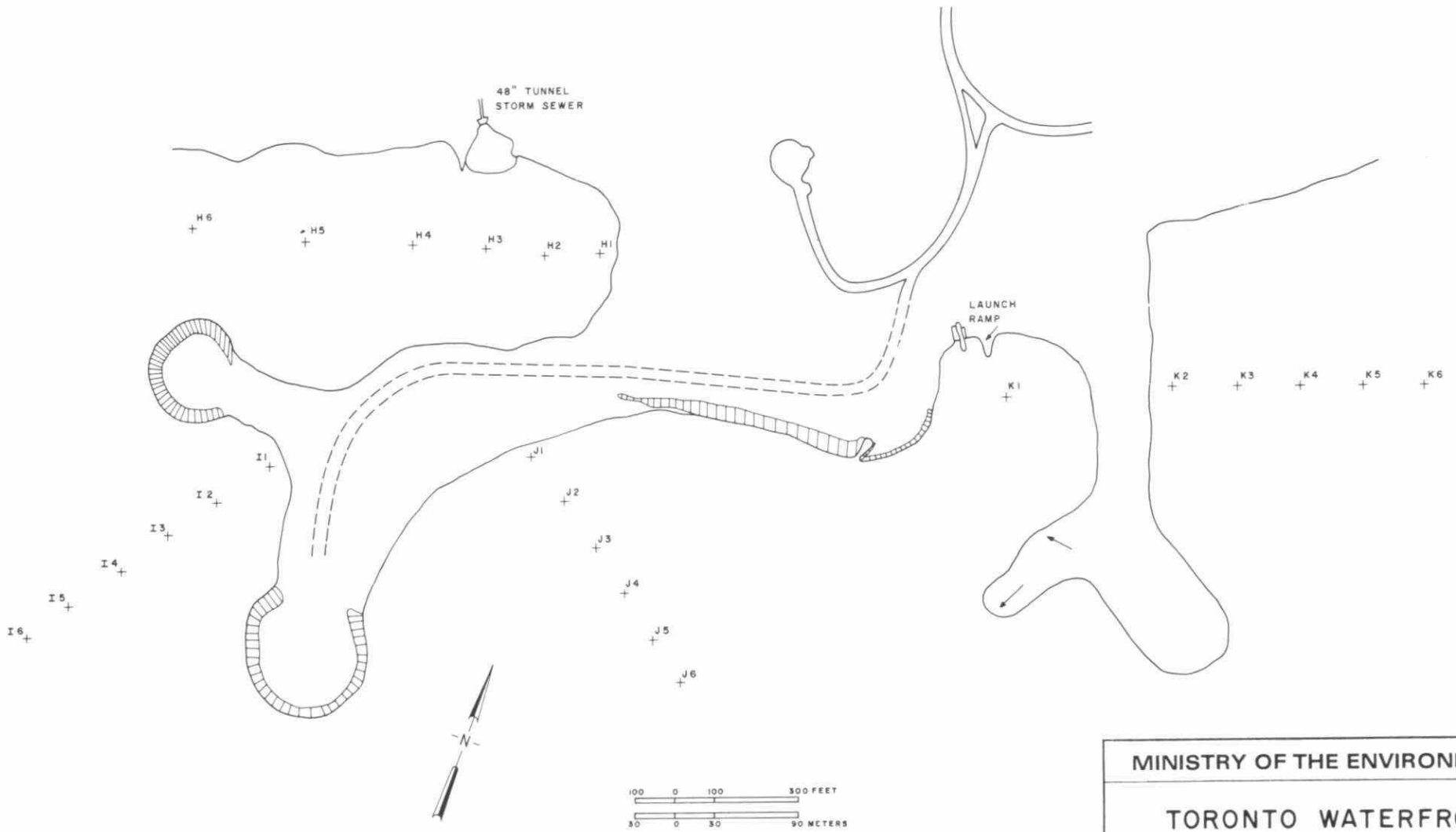
FIG. 2 - SAMPLING STATION LOCATIONS, BLUFFER'S PARK LANDFILL SITE



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The literature contained very little information on benthic invertebrates at these two sites. The International Joint Commission report of 1969 (Volume 3) included information gathered by the OWRC in 1966 to 1967 at inshore biological sampling stations. The report noted that the Humber Bay area was dominated by tubificids and that the fauna was indicative of heavy organic enrichment. The Scarborough Bluffs to Port Hope area was dominated by amphipods and lumbriculids in small numbers, and on the whole, the fauna indicated a low level of enrichment. Because of the general nature of this study there were few sampling stations near the landfill sites and strict comparisons with the present study locations were impossible.

The present report outlines the findings of the survey.

DESCRIPTION OF STUDY AREAS

Mimico Creek - Humber Bay Waterfront Areas

Both sites were located at the mouth of Mimico Creek, just west of the Humber River (Figure 1).

Mimico Creek Phase I Waterfront Area was started in 1972 by the MTRCA. All landfilling was completed at the time of the survey. Final armouring on the southern tip of the landfill was completed in late 1974. The outer shore of the site consisted of pebble beach between hard points with temporary rubble armouring. Approximately two thirds of the surface area of the site (total area approximately 6.9 hectares (17 acres)) had been seeded.

Humber Bay project Phase I, was started in 1971. At the time of the survey the site had a surface area of approximately 21.1 hectares (52.2 acres) with several active filling sites as marked in Figure 1. Shoreline on the exposed south of the landfill was temporarily armoured with dumped, broken concrete slabs and rubble but several areas between these points were unprotected.

Mimico Creek flows between the two landfill sites and drains mostly urban land. The Humber Sewage Treatment Plant with an average flow of approximately 28.2 m^3/day (62 million Imperial gallons per day) in 1975, discharged via a 2.75 metre (9 foot) diameter submerged outfall into Humber Bay (Figure 1).

The end of the outfall is equipped with diffusers to disperse treated sewage horizontally in various directions. The Humber River discharges to the Bay just east of the outfall. All three of these discharges contribute considerable amounts of suspended solids and organic matter to the area of the landfill sites in addition to the erosion and direct dumping of material from the landfill activities. Moreover, several storm sewers discharge to the lake along the shoreline near the sites.

Bluffer's Park Waterfront Area

This landfill site is located at the foot of Brimley Road in Scarborough. It was started in 1972 and had progressed to an area of about 5.5 hectares (13.5 acres) by the time of the survey. There were no large discharges near the site, however a 1.22 metre (48") diameter storm sewer tunnel entered the lake on the west side of the site. Final armouring of the western portion of the site was in place at the time of the survey. The bay in which the launch ramps were located as well as the tongue of fill extending out into the lake from the east side of the site were active filling zones during the survey Figure 2.

METHODS

Sampling was carried out from July 28 to 31, 1975; 54 stations were sampled at the Mimico - Humber site and 24 stations were sampled at the Bluffer's site.

A ponar dredge (23 cm. x 23 cm. or 9" x 9") was used to obtain samples. Sediment was examined in plastic basins and then washed in a screen pail with a mesh aperture of 0.65 mm. The invertebrates were then "picked" with forceps, preserved in 5% formalin and taken to the MOE laboratory for identification and enumeration by MOE Central Region staff. With the exception of worms which were identified only to the level of order (i.e. Oligochaeta), taxonomy was carried out to the family level. The samples are presently part of the biological collection of the MOE Central Region.

SEDIMENT DESCRIPTION

The sediments at each station are described in APPENDIX I.

Mimico-Humber Site

Transects A and B, in general, showed sand nearest the site, changing to a clay substrate. Transects C and D contained silt near the shore with a mixture of silt and underlying clay at the off-shore stations.

Transect E had an unsorted substrate near the site (probably construction materials) which changed to a cohesive highly organic sediment (gyttja) at the off-shore stations. The off-shore samples also contained leaf litter that was not decomposed.

Transect F had relatively uniform sediments consisting of silt and clay.

Shorelines stations (station 1 in each transect and all "G" stations) showed a great deal of variety in sediment types ranging from silt to rock and pieces of concrete. Depth at these shoreline stations varied considerably indicating that slumping and/or erosion of fill material had taken place in some areas more so than in other areas. Stations near active filling points had an unsorted sediment corresponding to fill material (eg. stations G9, G11, E2).

The filamentous green alga Cladophora sp. was found in several samples and was observed to cover rocks, etc. in waters close to shore.

Bluffer's Site

In general the sediment at the off-shore stations consisted of sorted sand with a thin veneer of silt. The bay in which transect H was sampled consisted of silt with organic debri. Station K1 at the launch ramps had a sediment consisting of silt. Pockets of silt and clay were found at Stations I3, I4 and I5. The stations adjacent to the shoreline consisted of silt or sand with silt.

Again the alga Cladophora sp. was found in some samples and along the shoreline, attached to submerged rocks.

BENTHIC INVERTEBRATE COMMUNITY STRUCTURE

Mimico-Humber Site

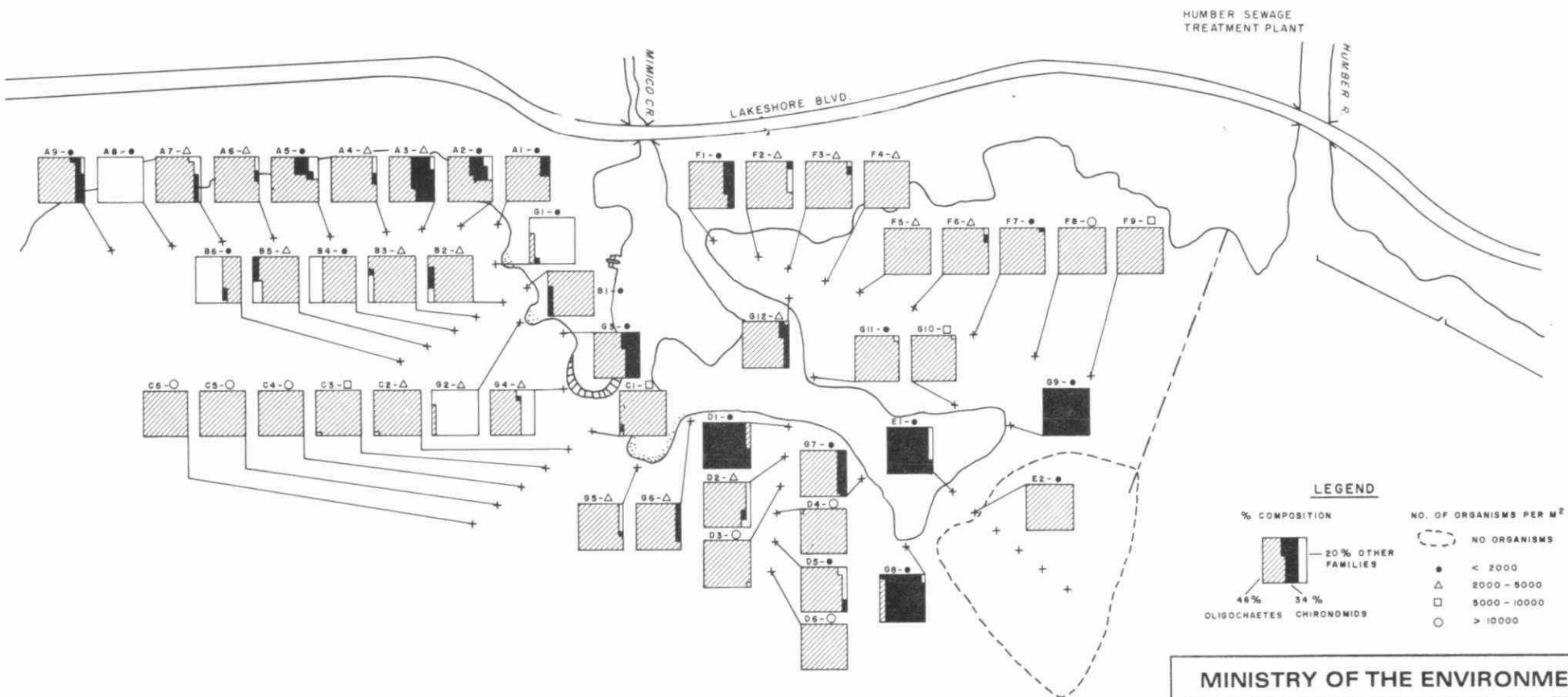
APPENDIX II outlines the numbers and types of benthic organisms found at each sampling location. A total of seven families were found. Figure 3 illustrates the density of organisms at each location, as well as the community structures.

The density of organisms varied greatly. Four samples were void of organisms indicating toxic conditions, and in contrast to this the highest density found was 55,000 organisms per square meter indicating heavy organic enrichment.

The four void samples (E3-E6) were all near the effluent discharge from the Humber Sewage Treatment Plant. Several more samples were taken and examined in the field to define the extent of the affected area. The contents of these observation samples were subsequently discarded. An area of about 120,000 m^2 as shown in Figure 3 was void of benthic invertebrates. Leaf litter, found in the samples from this area, was not decomposing, indicating that microorganisms responsible for the breakdown of this matter were also absent.

Stations on transects A and B as well as most shoreline stations had densities below 5000 organisms/m^2 (station G10 was an exception). High densities of organisms (mostly oligochaetes) were found along transects C and D indicating that the area south of the site was relatively more enriched. Stations in the bay formed by the Humber site (transect F

FIG. 3 - SAMPLING RESULTS, MIMICO CR. - HUMBER BAY SITE JULY 28 - 31 1975



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and stations G10-G12) showed moderate densities ranging from about 1100-10,000 organisms/m^2 except for station F8 where a high density of over 55,000 organisms per m^2 was found.

The largest number of families per station was found at stations in transect A and especially B. Shoreline stations, although providing the greatest substrate diversity, did not have as many families of organisms as expected.

In general, the fauna in the vicinity of the site was dominated by worms (Oligochaeta). These organisms are known to thrive in uniform, enriched substrates. Midge larvae of the family Chironomidae (Chironomids), although present at most stations represented only a small percent of organisms. They dominated the fauna at a few shoreline stations (D1, G8, E1, G9).

Other families were important parts of the community at some stations. Sow bugs (Asellidae) and Scuds (Gammaridae) were found at many shoreline stations and some off shore stations associated with Cladophora. Snails (Bulimidae) and especially Clams (Sphaeridae) were consistently found along transect A but were unevenly distributed over other transects in low numbers. It is interesting to note that snails and clams were found at only two shoreline stations (G11 and G12). Flatworms (family Planariidae) were found at 2 stations (B6 and G2).

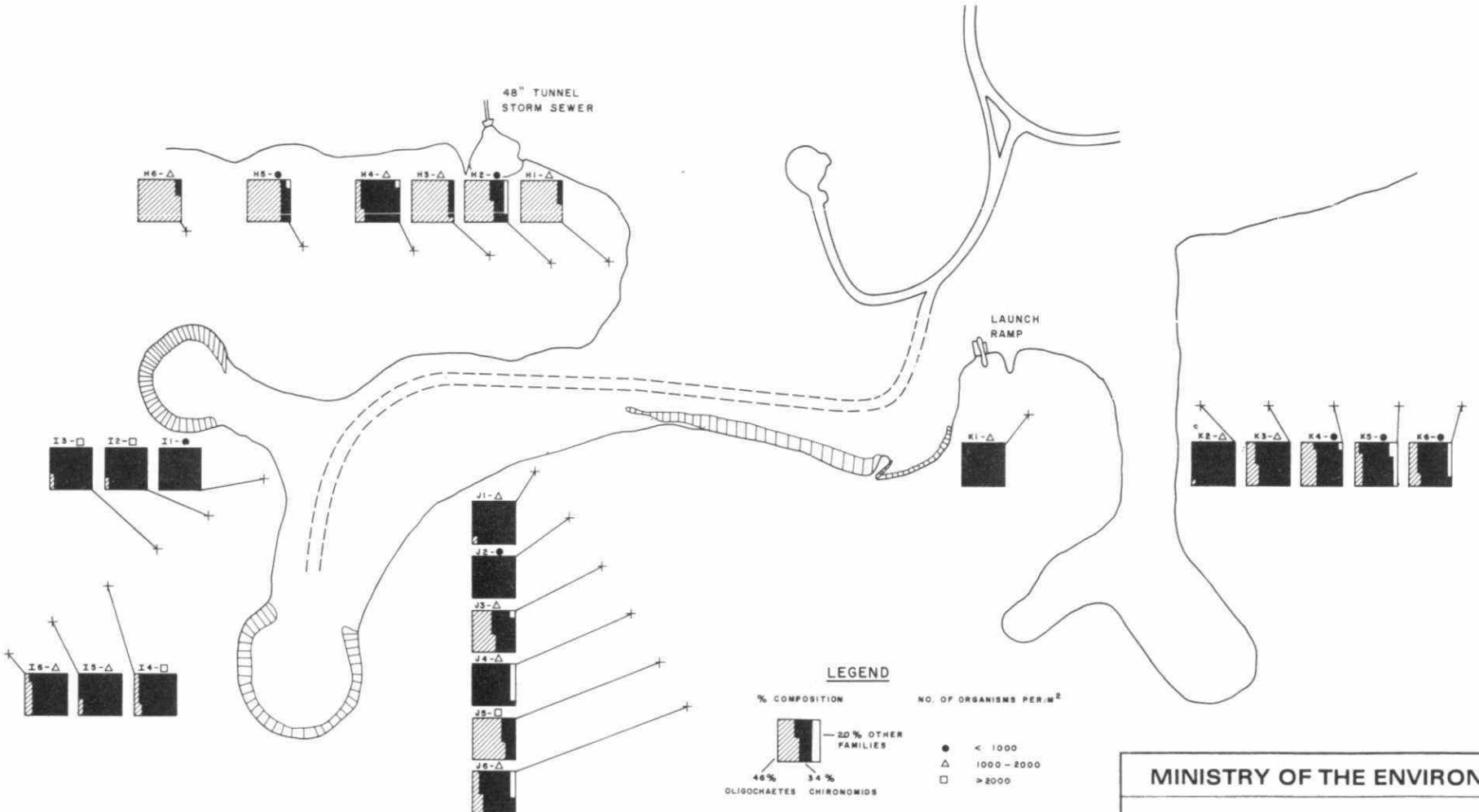
Bluffer's Site

APPENDIX III outlines the numbers and types of benthic organisms found at each sampling location. A total of five families were found. Figure 4 illustrates the density of organisms at each location, as well as the community structures.

Densities of organisms at the various sampling locations at Bluffer's Park site were between the range of about 200-4000 organisms per m^2. There were no indications of areas of particularly high or low density as were found at the Mimico-Humber site.

The community around the site was generally dominated by midge larvae (Chironomidae) with worms (Oligochaeta) of secondary importance. A noteable exception to this generalization was transect H in which oligochaetes were dominant over chironomids except for station H4. Scuds and clams had an uneven distribution over the stations and represented a very low percentage of the total organisms at the site.

FIG. 4 – SAMPLING RESULTS, BLUFFER'S PARK SITE JULY 30, 1975



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WATER QUALITY STATUS

In general, the variable density and low diversity of the benthic community around the Mimico-Humber site indicated fair to poor water quality. There were indications of toxic conditions over a significant area adjacent to the eastern tip of the site. Heavy organic enrichment was indicated south of the site and in the eastern embayment. The area west of the site showed signs of better water quality.

The benthic community around the Bluffer's Park site had comparatively low density and diversity. The relatively sparse community in areas exposed to currents was probably a result of shifting substrate. The embayment on the west side of the site showed a shift in community dominance to oligochaetes from chironomids, probably in response to changes in substrate and current conditions. Little organic enrichment of the waters of the bay was indicated by relatively low organism density.

LANDFILL EFFECTS

It is probable that the landfilling operation at the Mimico-Humber site did have some detrimental impact on the local benthic community. Evidence for this lies in the fact that in general, the western transects, (A and B) as well as the more off-shore stations on the other transects, had the highest diversity of organisms. These are also the stations where there was the least evidence of recent sediment deposition. Unfortunately, the effects of the landfill were clouded by the effects of the inflowing rivers, storm-water discharges and the effluent from the Humber Sewage Treatment Plant, all of which can exert an ecological impact similar to that caused by landfill erosion.

It appeared that the design of the bay at the Bluffer's Park site was such that sediment eroding from the bluffs and parts of the landfill was being trapped rather than being swept away by the normally strong inshore currents. The trapped sediment and protected waters contributed to a definite change in the benthic community indicating an impairment of water quality.

IMPACT OF HUMBER SEWAGE TREATMENT PLANT

The effluent from the Humber Sewage Treatment Plant has a severe localized effect on the bottom fauna, indicated by the absence of macroinvertebrates in the area near the discharge. As residual chlorine is normally the most toxic component of treated municipal sewage, it is likely that residual chlorinated compounds (e.g. chloramines) are causing this toxicity.

The dispersing feature of the Sewage Treatment Plant outfall, when originally designed and built, relied on proper mixing of treated sewage with lake water via inshore currents. The eastern end of the landfill was probably acting to partially shelter the area of the outfall, thus creating a localized toxic zone which may not have been in existence prior to the landfill project.

GENERAL DISCUSSION

The present study provided evidence that the impact of erosion from the two landfill sites on the local benthic fauna is minimal or negligible. While the general benthic community near the landfill sites is fairly dense and somewhat lacking in species diversity, this type of community is quite typical of the inshore community structure in Lake Ontario near Toronto. The shape and positioning of the landfill sites in relation to existing discharges have probably had a significant impact on the benthic fauna in localized areas at both landfill sites (i.e. off the Humber Sewage Treatment Plant discharge and the western bay of Bluffer's Park). Landfilling activities, if properly designed and constructed, may not significantly damage the benthic organisms which are of considerable importance in terms of fish food and overall ecological stability.

RECOMMENDATION

In the future, landfill sites should be designed to avoid restricting the dispersion of waste materials (from sewage treatment plant outfalls, rivers, storm sewers, etc.) into the Lake. Moreover, any embayments planned should be designed to encourage water exchange between the embayment and the open lake.

REFERENCES

Beak Consultants Ltd. 1975. Waterfront Environmental Monitoring Program, 3 volume report for The Metropolitan Toronto and Region Conservation Authority (MTRCA).

Beak Consultants Ltd. 1976. Waterfront Environmental Monitoring Program, report for MTRCA.

International Joint Commission 1969. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River Vol. 3 - Lake Ontario and the International Section of the St. Lawrence River.

Wilkins, W.D. 1974. Sediment Quality on the Toronto Waterfront Ontario Ministry of the Environment Report.

APPENDIX I Depth and Sediment Description of Stations

Sta	Depth(m)	Sediment Description
A1	1.0	concrete pieces with silt and gravel between
A2	2.0	fine sand
A3	3.0	fine sand
A4	3.0	fine sand
A5	4.0	fine sand with silt
A6	4.0	fine sand and silt over clay base
A7	4.0	fine sand
A8	4.0	brown clay
A9	4.0	sand veneer on clay
B1	1.0	sand and gravel
B2	2.0	sand and silt over clay
B3	3.0	sand and silt with organic debri
B4	4.0	gravel
B5	4.0	silt over clay
B6	5.0	clay with stones
C1	3.0	silt with sand
C2	4.0	silt with clay, sand, rubble
C3	5.0	silt
C4	6.0	silt
C5	6.0	silt with clay
C6	6.0	silt
D1	1.0	silt with sand and gravel
D2	3.0	silt with clay
D3	4.0	silt
D4	4.0	silt over clay
D5	5.0	silt veneer on hard base
D6	6.0	silt
E1	2.0	silt with gravel and sand
E2	2.5	silt, clay, sand, gravel
E3	3.0	gyttja with leaf litter
E4	4.0	gyttja
E5	4.5	gyttja
E6	5.0	gyttja
F1	1.0	silt and clay
F2	2.0	silt and clay with organic debri
F3	3.0	silt and clay with
F4	3.0	silt and clay with organic debri
F5	3.5	silt and clay with organic debri
F6	3.0	silt and clay
F7	3.5	silt and clay
F8	4.5	silt and clay
F9	5.0	silt and clay

APPENDIX I (cont'd)

Sta	Depth(m)	Sediment Description
G1	3.0	rock with silt between
G2	1.5	rock
G3	3.0	sand
G4	6.0	silt layer over sand
G5	4.0	rock and clay
G6	5.0	silt veneer over sand
G7	3.0	silt veneer over sand
G8	7.0	silt layer over sand with organic debri
G9	4.0	sand, silt, clay, gravel
G10	3.5	silt with sand
G11	1.0	clay, silt, sand, gravel
G12	2.5	silt
H1	0.5	clayey silt with organic debri
H2	1.5	silt with organic debri
H3	2.0	clayey silt with organic debri
H4	1.5	silt with organic debri
H5	1.5	clayey silt with organic debri
H6	2.0	clayey silt
I1	1.0	sand with silt
I2	4.5	sandy silt
I3	3.0	silt clay
I4	5.0	silty clay
I5	5.0	silty clay
I6	5.0	silt layer over packed sand

Sta	Depth(m)	Sediment Description
J1	2.0	silt veneer over sand
J2	4.0	sand
J3	4.0	sandy silt
J4	6.0	silt veneer over sand
J5	6.0	clayey silt with organic debri
J6	7.0	sandy silt with clay
K1	3.0	silt
K2	2.5	sandy silt with organic debri
K3	3.0	sandy silt
K4	3.0	layer of silt over sand
K5	3.5	silty sand
K6	4.0	sandy silt

APPENDIX II

Benthic Invertebrates Collected Near Mimico Creek-Humber Bay Landfill July 28-31, 1975

Sta.	Worms Tubificidae *		Midges Chironomidae		Sow Bugs Asellidae		Scuds Gammaridae		Snails Bulimidae		Clams Sphaeriidae		Flatworms Planariidae		Total No./m^2
A1	1365	92.2	115	7.8											1480
A2	788	75.9	173	16.6			19	1.8			58	5.5			1038
A3	1115	52.7	942	44.5							58	2.7			2115
A4	2308	93.7	58	2.3							46	3.9			2412
A5	1211	77.7	231	14.8							115	7.4			1557
A6	4500	94.7	96	2.0					19.	.4	134	2.8			4749
A7	2365	79.3	192	6.4					77	2.6	346	11.6			2980
A8									19	100					19
A9	730	79.1	135	14.6			58	6.2							923
B1	558	93.5	38	6.5											596
B2	3442	92.7	173	4.7			19	.5			58	1.5			3692
B3	2827	93.0	38	1.3			96	3.2	19	.6	58	1.9			3038
B4	135	70.0					58	30.0							193
B5	2115	85.3	135	5.4			231	9.3							2481
B6	250	37.0	19	2.9	269	40.0			19	2.9	19	2.9	96	14.3	672
C1	5231	97.5	77	1.4	19	.3	38	.7							5365
C2	4134	99.5	19	.5											4153
C3	6846	99.7	19	.3											6865
C4	G40000	100			58	.0	19	.0							G40077
C5	G40000	100							77	.0					G40077
C6	G40000	100													G40000

APPENDIX II (Cont'd)

Benthic Invertebarates Collected Near
Mimico Creek-Humber Bay Landfill July 28-31, 1975

Sta.	Worms Tubificidae *		Midges Chironomidae		Sow Bugs Asellidae		Scuds Gammaridae		Snails Bulimidae		Clams Sphaeriidae		Flatworms Planariidae	Total No./m^2
D1	38	5.7	635	94.3										673
D2	1827	86.4	38	1.8	58	2.7	192	9.1						2115
D3	12076	99.5									58	.5		12134
D4	17076	99.9			19	.1								17095
D5	596	88.6	19	2.9					38	5.7				672
D6	37556	99.8									58	.1		37614
E1			250	92.8			19	7.2						269
E2	38	100												38
E3	No organisms													0
E4	No organisms													0
E5	No organisms													0
E6	No organisms													0
F1	942	83	192	17										1134
F2	2961	93.3	135	4.2					38	1.2				3172
F3	3038	97.5	38	1.2					38	1.2				3114
F4	3384	98.9	38	.1										3422
F5	2211	100												2211
F6	2615	97.1	38	1.4					38	1.4				2691
F7	1654	99.5	19	.5										1673
F8	55248	100												55248
F9	6461	100												6461

APPENDIX II (Cont'd)

Benthic Invertebrates Collected Near
Mimico Creek-Humber Bay Landfill July 28-31,1975

Sta.	Worms Tubificidae *		Midges Chironomidae		Sow Bugs Asellidae		Scuds Gammaridae		Snails Bulimidae	Clams Sphaeriidae		Flatworms Planariidae		Total No./m^2
G1	96	6.2	19	1.2	865	55.5	580	37.0						1560
G2	135	6.3			1558	73.0	423	19.8				19	.9	2135
G3	574	66.7	287	33.3										861
G4	1846	67.6	19	.7			865	31.7						2730
G5	3634	93.1	19	.5			250	6.4						3903
G6	1884	91.6	173	8.4										2057
G7	1481	80.2	365	19.8										1846
G8	135	9.3	1288	89.3			19	1.3						1442
G9			423	100										423
G10	9846	99.8	19	.1										9865
G11	1865	99.0								19	1			1884
G12	2750	86.6	404	12.7						19	.6			3173

* two columns refer to No. of organisms per m^2 and % sample

G = greater than

APPENDIX III

Benthic Invertebrates Collected Near Bluffer's Park Landfill July 30, 1975

Sta.	Worms Tubificidae *		Midges Chironomidae		Sow Bugs Asellidae		Scuds Gammaridae		Snails Bulimidae	Clams Sphaeriidae		Flatworms Planariidae	Total No./m^2
H1	1327	94.5	58	4.1						19	1.4		1404
H2	327	65.4	135	26.9	19	3.8	19	3.8					500
H3	1269	91.6	96	6.9						19	1.4		1384
H4	154	13.3	981	85.0						19	1.6		1154
H5	692	80.0	154	17.8			19	2.2					865
H6	1788	95.9	77	4.1									1865
I1			404	100									404
I2	58	2.8	1961	97.1									2019
I3	115	3.8	2884	96.2									2999
I4	288	12.4	2038	87.6									2326
I5	77	4.0	1846	96.0									1923
I6	308	18.2	1385	81.8									1693
J1	19	1.5	1231	98.5									1250
J2			231	100									231
J3	596	54.4	481	43.9						19	1.7		1096
J4			1135	90.8			115	9.2					1250
J5	2884	74.6	981	25.4									3865
J6	288	24.6	808	68.8			77	6.6					1173
K1			1019	100									1019
K2	19	1.8	1077	98.2									1096
K3	269	25.5	788	74.5									1057
K4	365	38.8	558	59.2						19	2.0		942
K5	154	17.8	596	68.9			115	13.3					865
K6	58	23.1	173	69.2			19	7.7					250

* two columns refer to No. of organisms per m^2 and % sample